

NIH COMMON FUND HIGH-RISK HIGH-REWARD RESEARCH SYMPOSIUM

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SPEAKER ABSTRACTS – DAY 2 (DEC. 16, 2014)

Neural Systems Approach to Monitoring Brain States During General Anesthesia and Sedation

Awardee: Patrick L. Purdon

Award: New Innovator Award

Awardee Institution: Massachusetts General Hospital / Harvard Medical School, Boston, MA

Over the past several years, with the support of an NIH New Innovator Award, I have been able to make fundamental advances on two of the most challenging problems in medical science: to understand how general anesthetic drugs produce states of unconsciousness, and to develop a means to clinically monitor those states. Historically, the field of anesthesiology has sought out a unitary mechanism—one single mechanism—to explain how all anesthetics produce unconsciousness. In contrast, my team and I found that general anesthetic drugs produce different states of unconsciousness by inducing profound neurophysiologic oscillations that disrupt normal brain function. These oscillations are structured in a way that relates directly to the underlying molecular- and circuit-level neuropharmacology for these drugs, such that each anesthetic drug class has a unique “EEG signature.” Our work resolves the decades-long contradiction between the search for a unitary mechanism, and the modern evidence that different anesthetic drugs act at unique molecular receptors. Furthermore, through human intracranial studies and computational modeling studies, my work has established the connection between clinically-observable EEG oscillations under anesthesia, and brain activity at the neuronal and local field levels. These advances represent a quantum leap in understanding that would not have been possible using conventional methods under the prevailing hypotheses of the day.

I have rapidly translated this knowledge into clinical innovations that are already being put into practice. Anesthesiologists now have the ability, for the first time, to precisely monitor the brain states of their patients during general anesthesia. Over the past three years, I have been teaching anesthesiologists how to use the EEG to monitor and manage their patients. This past year, I published a CME-accredited website, AnesthesiaEEG.com, that allows anyone to obtain this knowledge, free of charge. I have gone on to characterize age-related anesthetic effects in children and the elderly, providing fundamental insights on how to care for these uniquely vulnerable patients. I have filed 11 patents related to monitoring or control of consciousness during anesthesia and sleep. Recently, I secured a technology licensing agreement with a major medical device company to implement and make commercially available novel techniques to monitor brain states under anesthesia. A first device employing these technologies is due to be released in the market in 2015. I am also developing novel technologies to control administration of anesthetic drugs, to improve sleep monitoring and sleep therapeutics, and to improve anesthetic monitoring in children.